



DARTMOUTH COLLEGE, HANOVER, NEW HAMPSHIRE

Rice and Rice Products as Potential Dietary Sources of Arsenic in Pregnant Women and Kids

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Research Project 1: Arsenic and Maternal and Infant Immune Function

Margaret Karagas, Susan Korrick,
Matt Davis, Shohreh Farzan



Center Overview

Community Engagemen
Vicki Sayarath
Carolyn Murray



Children's Health Special
John Moeschler

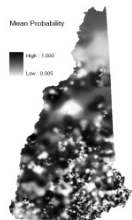


Project 2 (Pilot): Food Borne Exposure to Arsenic During the First Year of Life

Kathy Cottingham



Project 3 (Pilot): An Integrated Geospatial and Epidemiological Study of Associations Between Birth Defects and Arsenic Exposure in New England

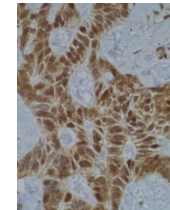


Xun Shi

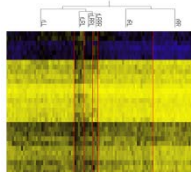


Project 4 (Pilot): Determining how Arsenic Modulates Hedgehog Signaling During Development

David Robbins



New Project 5: Epigenetic Markers of Exposure and Development



Carmen Marsit



Arsenic Drinking Water Standards

World Health Organization

- 1958 – 200 $\mu\text{g/L}$
- 1963 – 50 $\mu\text{g/L}$
- 1993 – 10 $\mu\text{g/L}$

US EPA

- 2001 – 10 $\mu\text{g/L}$

Some states

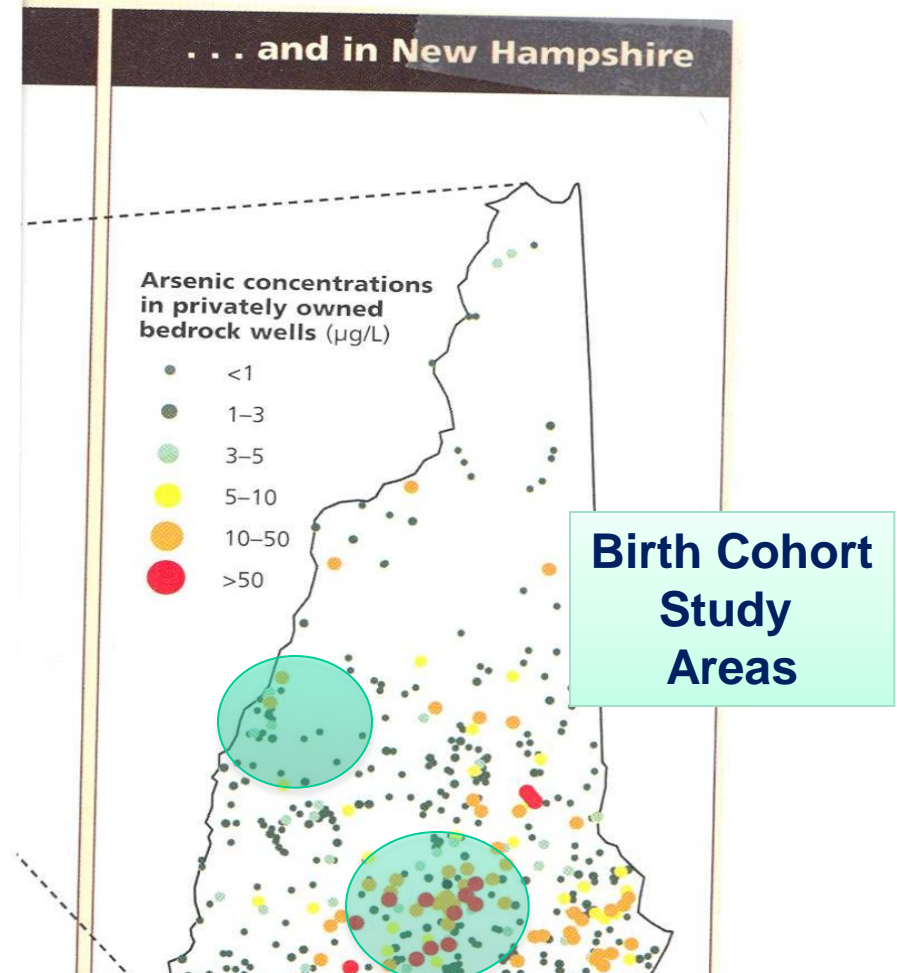
- 5 $\mu\text{g/L}$



Private Wells Not Regulated

Arsenic in Household Drinking Water New Hampshire, USA

- 40% of New Hampshire households served by private water systems
- Restricted study to pregnant women with private well at home
- Included a region with high concentrations based on our earlier work



**15% of pregnant women – tap water exceeds the
MCL of 10 $\mu\text{g/L}$ As**

Dietary Sources of Arsenic

- Diet is the main source of arsenic exposure for most.
- There are no statutory limits for arsenic content of food sold in the US and EU.
- In China the limit is 0.15 ug/g.



EFSA Journal 2009; 7(10):1351

SCIENTIFIC OPINION

Scientific Opinion on Arsenic in Food¹

EFSA Panel on Contaminants in the Food Chain (CONTAM)^{2, 3}

European Food Safety Authority (EFSA), Parma, Italy

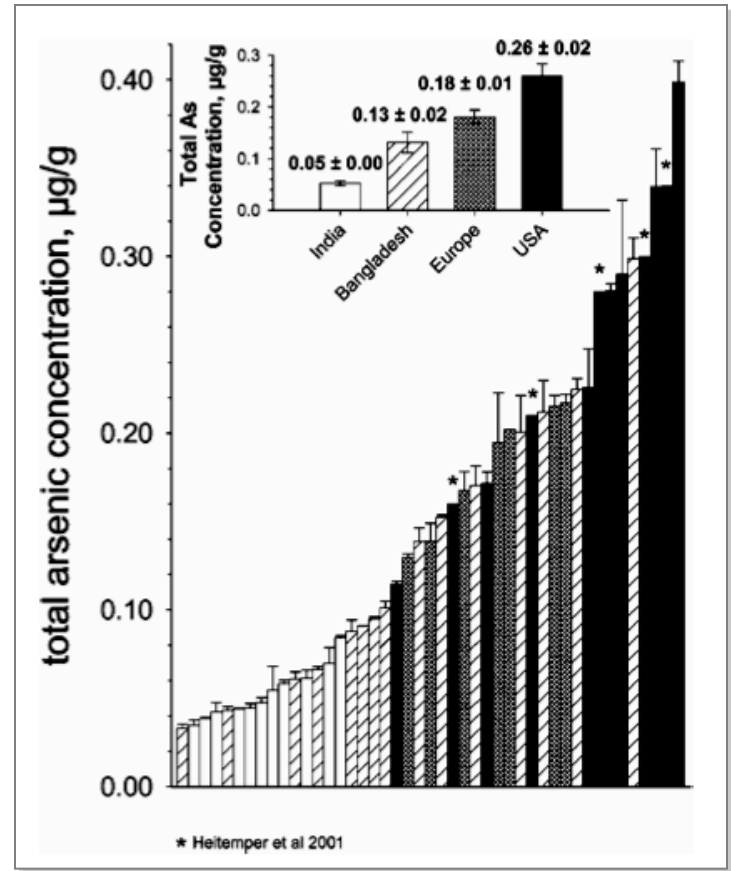
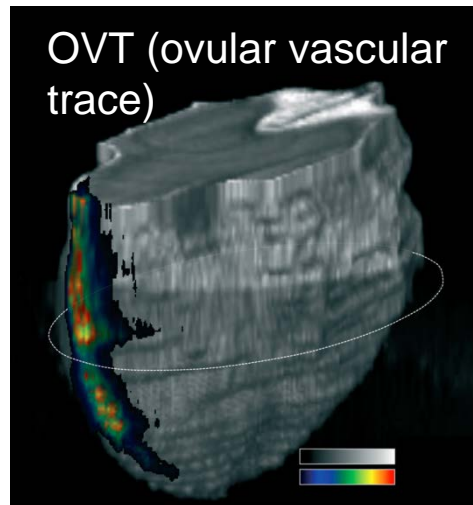
“Dietary exposure to arsenic should be reduced”

Arsenic in rice

Williams et al., 2005; Meharg et al., 2008.; Carey et al., 2011



“USA long grain rice had the highest mean arsenic level in the grain at $0.26 \mu\text{g As g}^{-1}$ ”

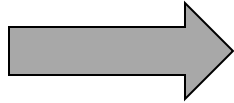


Preliminary Studies



Pregnancy

Water & rice in
relation to
urinary arsenic



Infant/Toddler

As content in
formulas



Child

Rice and rice
product
consumption in
relation to urinary
arsenic

New Hampshire Birth Cohort Study

Pregnancy → Delivery → Months 4 → Months 8 → Year 1



12-16 Weeks
Eligibility screen

24-28 Weeks
Enrollment

- Questionnaire
- Maternal blood, urine, hair, toenail

Maternal diet (FFQ, diary)
Prenatal records:
Maternal Infection

- Gest. age,
- birth weight

- Maternal/infant infection
- Cord blood (immune profile, epigenetics)
- Placenta (gene expression)
- Meconium (microbiome)

- Infant infection
- Infant Diet
- Infant Urine/Stool, Breast Milk

- Infant infection
- Infant Diet
- Infant Urine/Stool Breast Milk

- Infant health/ infection
- Infant/ Maternal diet(FFQ)*
- Pediatric record
- Infant Blood/Urine/ Stool
- *Physical exam and developmental evaluation*

75-80% participation ~100% urinary As, water/diet

Pregnancy Exposure



ID Number: _____
Prenatal Clinic Location: _____
Date: ____/____/____
(month/day/year)

Prenatal Questionnaire

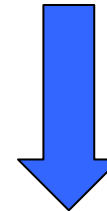


If you have any difficulty answering any of these questions, the Study Coordinator will be happy to assist you. Thank you!

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v. 08.16.11

- Baseline questionnaire
- Chart review



As3 \mapsto As5 \mapsto MMA \mapsto DMA AsB



ICP-MS



Samples:

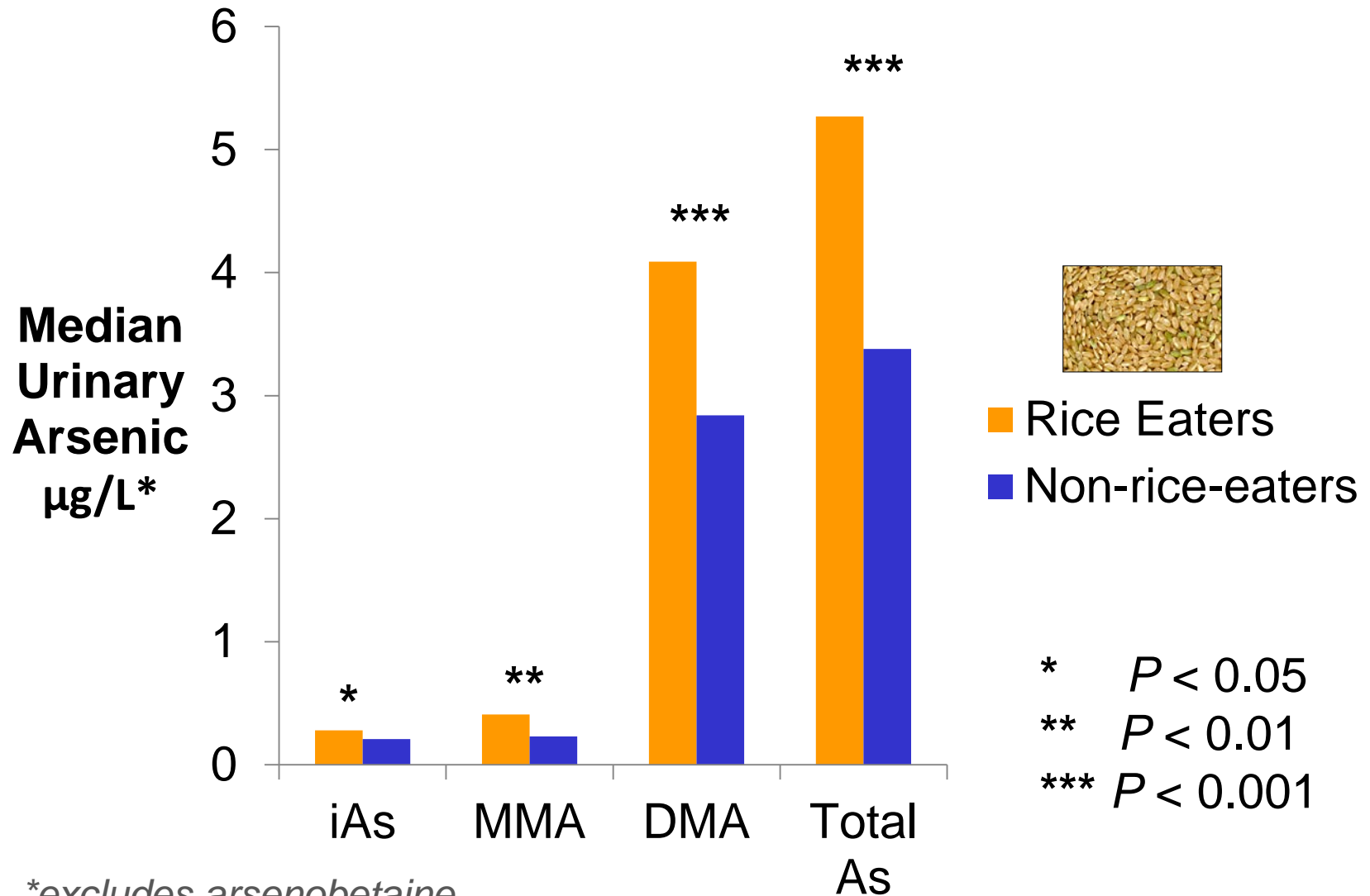
- Home water,
- Spot Urine
- 3-day water, seafood and rice intake

CCES WATER AND SEAFOOD INTAKE RECORD 09/02/08

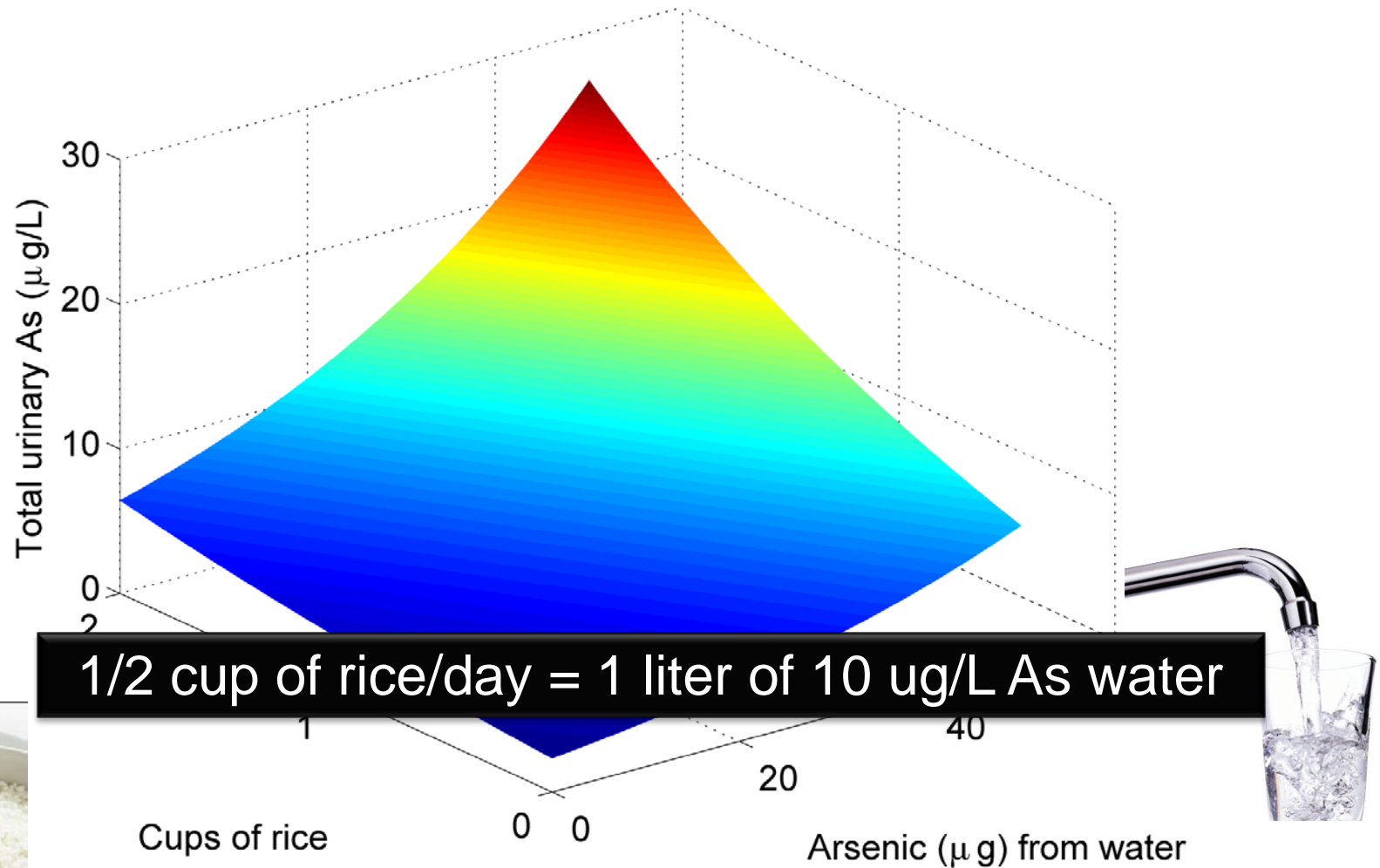
INSTRUCTIONS: Please record your water and seafood intake for the three (3) days before your interview.

	3 days before	2 days before	Day before
Record the Number of Cups of Water you Drink (1 cup=8 oz.)			
Tap water from your home	Cups	Cups	Cups
Tap water from your work			
Tap water from a restaurant			
Bottled water			
Other			
Record the Number of Cups of Water you used from your Household Tap Water in Beverages such as Tea, Coffee, etc. (1 cup=8 oz.)			
Home tap water used in beverages	Cups	Cups	Cups
Record the Number of Cups of Water from your Household Tap Added to Food, such as Soups, Jellies, etc. (1 cup=8 oz.)			
Home tap water added to food	Cups	Cups	Cups
Soup			
Jelly			
Other			
Record Any Seafood You Ate. Specify the Type of Seafood, such as Tuna, Salmon, Shrimp, etc., and the Number of Portions You Ate. (1 portion=4 oz.)			
Type of Seafood	Portions	Portions	Portions
Record the Number of Cups of rice and rice cereal eaten (1 cup=8 oz.)			
Rice made with home tap water	Cups	Cups	Cups
Rice, pre-made or not using home tap water			
Rice cereal using home tap water (e.g., hot cereals prepared with water)			
Rice cereal in a box (e.g., Rice Krispies, Rice Chex)			
CURRENT WEIGHT			
LAST MEAL Date (month/year) _____ Time (24 Hr. Clock) _____			
LAST VOID Date (month/year) _____ Time (24 Hr. Clock) _____			
URINE SAMPLE COLLECTED Date _____ Time (24 Hr. Clock) _____			

Urinary arsenic higher in rice eaters (n=229)



Water Arsenic & Rice Intake Contribute to Urinary Arsenic



Infant Exposure

Pilot Project 2: Kathy Cottingham (Poster)

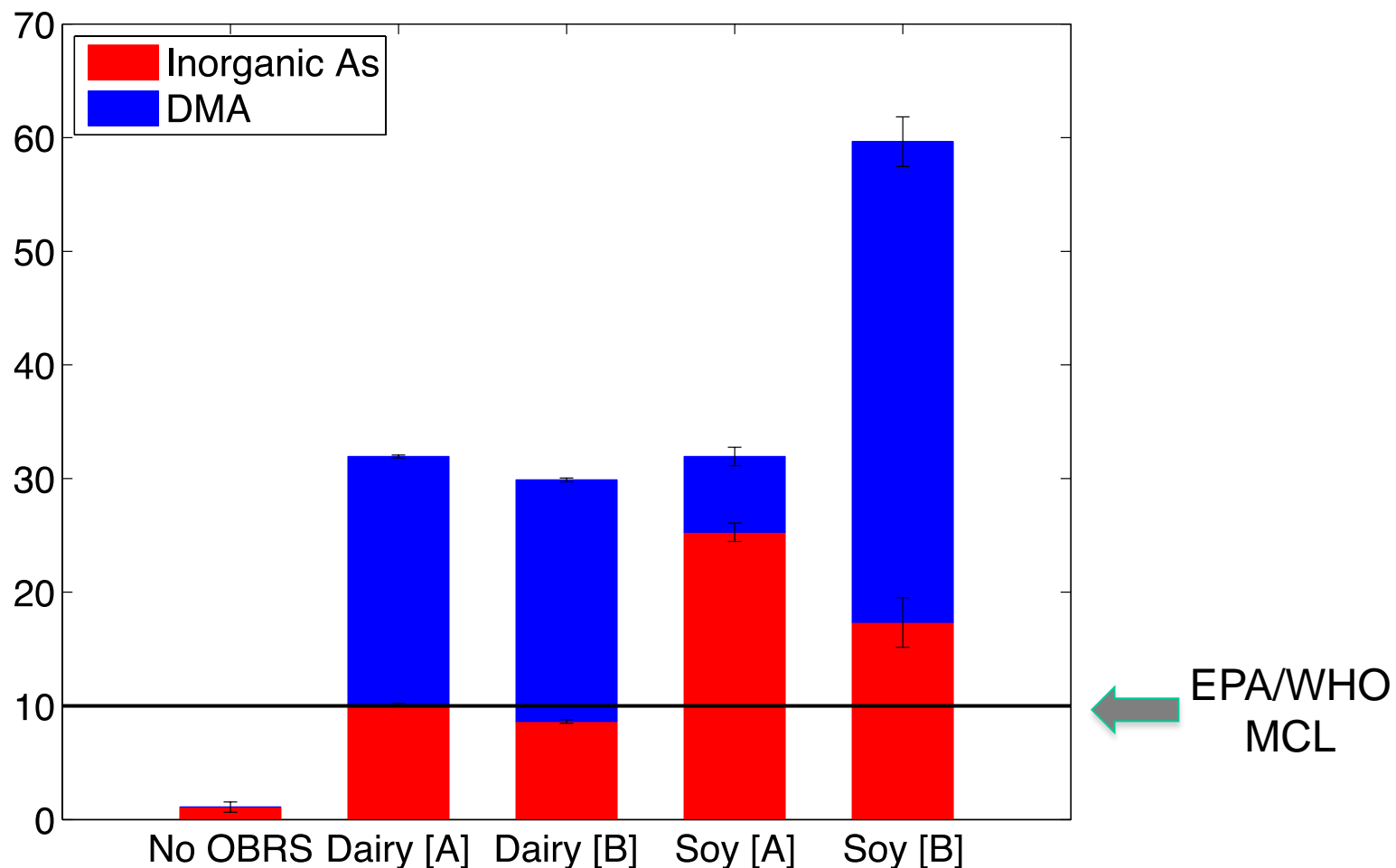
Dietary contributors of As exposure in infants?



How is early life As exposure best measured?



Formulas with organic brown rice syrup contained As when reconstituted with As-free water



Limitations/Future Studies

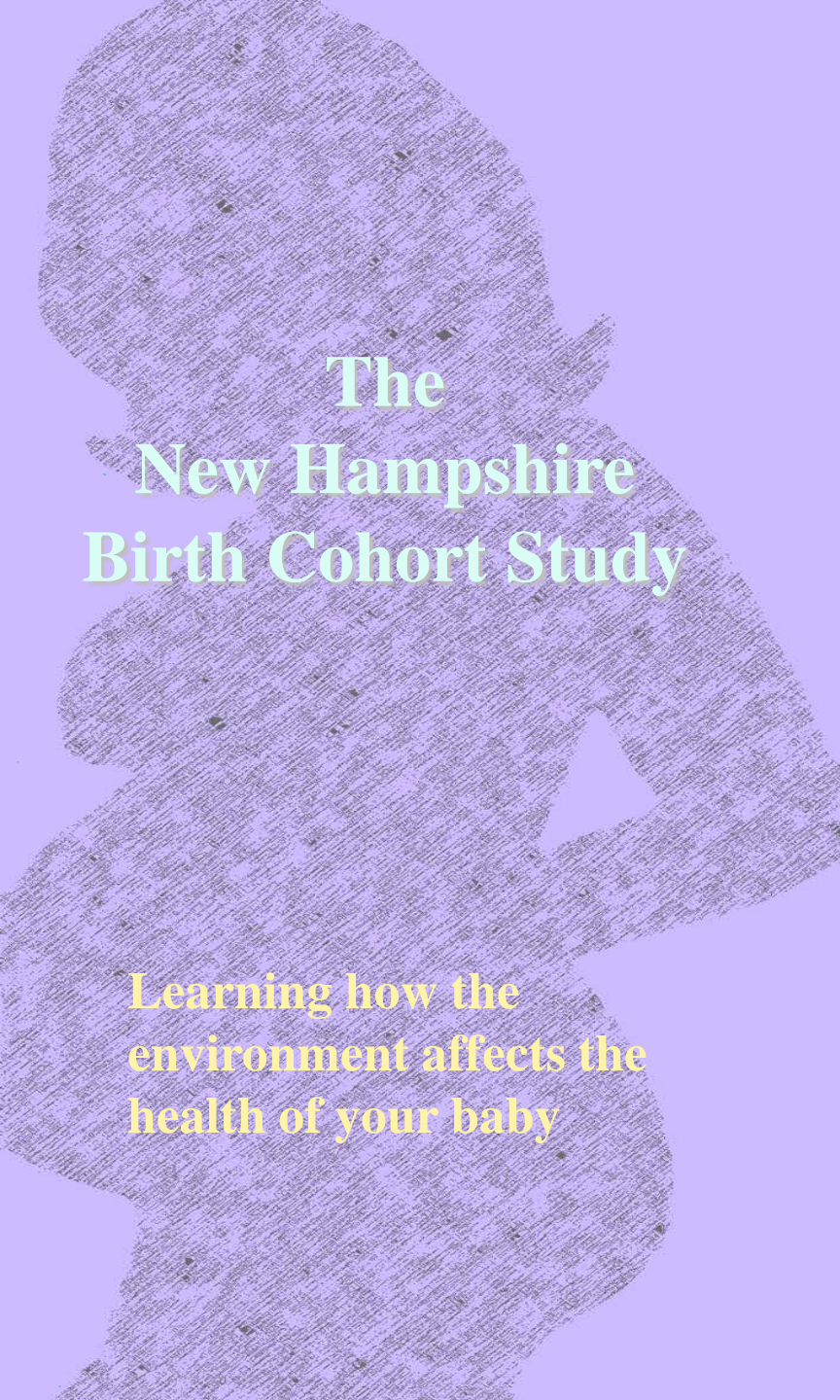
1. Analysis of **individual's** As exposure from rice:
 - No testing of actual rice samples
 - Nor specific brand/country of origin information
 - Didn't fully account for rice fillers/sweeteners
2. Analysis of infant/toddler **formula**
 - No actual infant exposure levels i.e., biomarkers such as urine
3. We need to understand the **health impacts** of food sources of As exposure.

Conclusions

- Estimated arsenic intake via **well water** contributes to urinary arsenic concentrations in pregnant women.
- **Rice**, alone, and without accounting for the arsenic content of rice, is associated with urinary arsenic concentrations in pregnant women and kids
- Need to consider multiple exposure routes when designing arsenic reduction strategies in the U.S.

Need for private well testing is clear.

Need to be careful about making dietary recommendations to pregnant women and children.



The New Hampshire Birth Cohort Study

Learning how the
environment affects the
health of your baby

Collaborators

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Clinicians throughout the State